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Data Paper

Eleven years' data of grassland management in Germany

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Abstract

Background

The 150 grassland plots were located in three study regions in Germany, 50 in each region. The dataset describes the yearly grassland management for each grassland plot using 116 variables.

General information includes plot identifier, study region and survey year. Additionally, grassland plot characteristics describe the presence and starting year of drainage and whether arable farming had taken place 25 years before our assessment, i.e. between 1981 and 2006. In each year, the size of the management unit is given which, in some cases, changed slightly across years.

Mowing, grazing and fertilisation were systematically surveyed:

Mowing is characterised by mowing frequency (i.e. number of cuts per year), dates of cutting and different technical variables, such as type of machine used or usage of conditioner.

For ***grazing***, the livestock species and age (e.g. cattle, horse, sheep), the number of animals, stocking density per hectare and total duration of grazing were recorded. As a derived variable, the mean grazing intensity was then calculated by multiplying the livestock units with the duration of grazing per hectare [LSU days/ha]. Different grazing periods during a year, partly involving different herds, were summed up to an annual grazing intensity for each grassland.

For ***fertilisation***, information on the type and amount of different types of fertilisers was recorded separately for mineral and organic fertilisers, such as solid farmland manure, slurry and mash from a bioethanol factory. Our fertilisation measures neglect dung dropped by livestock during grazing. For each type of fertiliser, we calculated its total nitrogen content, derived from chemical analyses by the producer or agricultural guidelines (Table 3).

All three management types, mowing, fertilisation and grazing, were used to calculate a combined land use intensity index (LUI) which is frequently used to define a measure for the land use intensity. Here, fertilisation is expressed as total nitrogen per hectare [kg N/ ha], but does not consider potassium and phosphorus.

Information on additional management practices in grasslands was also recorded including levelling, to tear-up matted grass covers, rolling, to remove surface irregularities, seed addition, to close gaps in the sward.

New information

Investigating the relationship between human land use and biodiversity is important to understand if and how humans affect it through the way they manage the land and to develop sustainable land use strategies. Quantifying land use (the 'X' in such graphs) can be difficult as humans manage land using a multitude of actions, all of which may affect biodiversity, yet most studies use rather simple measures of land use, for example, by creating land use categories such as conventional vs. organic agriculture. Here, we provide detailed data on grassland management to allow for detailed analyses and the development of land use theory. The raw data have already been used for > 100 papers on the effect of management on biodiversity (e.g. Manning et al. 2015).

Keywords

Grassland management survey, fertilisation, grazing, mowing, livestock units, Biodiversity-Exploratories, questionnaire, farming practice, grassland maintenance, nitrogen, temporal variation, intensification of grassland use

Introduction

Grasslands can harbour high biodiversity and fulfil important ecosystem functions and services, such as food and habitat provision for livestock, protection of soil and water resources, carbon sequestration and aesthetic appeal (Carlier et al. 2009, Hönigová et al. 2012, Gossner et al. 2016, Simons et al. 2017). In addition to the conversion of grasslands to other land use forms, grasslands worldwide are also changed by land use intensification. Land use intensification of grasslands includes, for example, increased fertiliser input, application of pesticides, increased number of cuts in meadows or increased stocking densities in pastures (Humbert et al. 2009, Boch et al. 2016, Klaus et al. 2018. As a result of continued land use intensification, high value natural grasslands, i.e. extensively managed grasslands, have seen a decline throughout Europe (Veen et al. 2009).

Increasing management intensity in grasslands has been shown to decrease alpha, (i.e. local, diversity) and also beta diversity, i.e. intensification leads to homogenisation of communities across trophic groups including plant, invertebrates and birds (Humbert et al. 2009, Gossner et al. 2016, Manning et al. 2015, Renner et al. 2014, Socher et al. 2013). Intensification affects biodiversity directly and indirectly. For example, mowing itself and the use of conditioners, i.e. a farm implement that uses mechanical force to promote faster and more even drying of biomass, cause direct mortality of insects (Humbert et al. 2010a, Humbert et al. 2010b). Indirect effects include changes in plant community composition, for example, by increased fertilisation, that can then affect insect diversity.

Until now, little attention has been paid to long-term in-depth assessments of land use practices in grassland systems. The intensity and timing of mowing, grazing and fertilisation can differ within and between years on particular grasslands (Kleinebecker et

al. 2018) and the effect of such variability on biodiversity changes is considerable (but see, e.g. Allan et al. 2014). Grassland management consists of various management components such as mowing, grazing or fertilisation that may jointly or singly affect biodiversity. Moreover, there are interactions between different management activities, for example, fertiliser application results in higher biomass production, which is often associated with more frequent mowing (Blüthgen et al. 2012, Busch et al. 2018, Humbert et al. 2009Busch et al. 2018). To understand more mechanistically how land use intensification in grasslands affects biodiversity, detailed information on grassland management is needed, ideally for a large number of grasslands over several years.

Within the framework of the *Biodiversity-Exploratories* programme (www.biodiversity-exploratories.de), we have thoroughly monitored land use of 150 grassland plots for 11 years to investigate temporal variation in land management within three study regions in Germany (Fig. 1). These plots represented gradients of land use intensity typical for our study regions and were managed by mowing, grazing and fertilisation (Fischer et al. 2010). Detailed information on grassland management of all 150 grassland plots was obtained annually from farmers using a standardised questionnaire (Table 1). Here, we present the data of the corresponding management questionnaire that form the basis of most analyses of effects of land use intensification on biodiversity and ecosystem functioning in grasslands within the Biodiversity-Exploratories. With this dataset, we provide knowledge on how land use intensity in temperate grasslands varies across spatial and temporal scales. The components reported here also form the basis on an integrated land use intensity index used in the programme to study its integral effects on biodiversity in grasslands (Blüthgen et al. 2012).

Table 1.

Overview of all variables of the data set: BE_landuse_grassland_2006-2016.csv received from the management questionnaire.

Variable	**Type of data**	**Units**	**Range of numeric variables (min-max)**	**Description (English)**
ID	Text	-	-	Unique identifier composed of the columns PlotID and Year
Study region	Text		-	ALB = Schwäbische Alb HAI = Hainich SCH = Schorfheide
Year	Integer	yyyy	-	Year of management
Date	Date	dd.mm.yyyy	-	Date of interview

Variable	Type of data	Units	Range of numeric variables (min-max)	Description (English)
PlotID	Text	-	-	Experimental Plot IDs formatted as (A|H|S)EG with consecutive numbering. Abbreviations are: A = Schwäbische Alb, H = Hainich, S = Schorfheide E = Experimental Plot G = Grassland, e.g. AEG01
Drainage	Text	-	-	Measure of drainage and the description of the method (free text)
StartDrainage	Integer	yyyy	-	Starting year of grassland drainage, if applicable
WaterLogging	Boolean	yes/no	-	Activities on water logging, e.g. for water regulation of fen soils
Agriculture1981	Boolean	yes/no	-	Use of grassland between 1981 to 2006, i.e. (temporal) conversion of grassland into arable land
SizeManagementUnit_ha	Numeric	ha	0.49-187.1	Size of the management unit in the survey year, often larger than the 50 x 50 m study plot itself
Grazing				
StartGrazing	Text	Month	-	Starting month of the first grazing period in the survey year
EndGrazing	Text	Month	-	End of the last grazing period in the survey year
Livestock1	Text		-	Type of animal in first grazing period
StartGrazingPeriod1	Text	month	-	Starting month of first grazing period for livestock 1
EndGrazingPeriod1	Text	month	-	Ending month of first grazing period for livestock 1
Livestock, Start/End GrazingPeriod 2-4 …			-	Identical information for grazing periods 2-4, if applicable.
Cattle6months1	Integer		0-95	For Grazing period 1: Number of cattle with an age up to 6 months (cattle up to 6 months = 0.3 LS* per day)
Cattle6-24months1	Integer		0-200	For Grazing period 1: Number of cattle with an age between 6 months and 2 years (= 0.6 LS*)
CattlePlus2years1	Integer		0-300	For Grazing period 1: Number of cattle older than 2 years (= 1 LS*)
SheepGoat1year1	Integer		0-1000	For Grazing period 1: Number of sheep or goats with an age up to 1 year (= 0.05 LS*)

Variable	Type of data	Units	Range of numeric variables (min-max)	Description (English)
SheepGoatPlus1year1	Integer		0-1500	For Grazing period 1: Number of sheep or goats older than 1 year (= 0.1 LS*)
Pony1	Integer		0-400	For Grazing period 1: Number of ponies and small horses (= 0.7 LS*)
Horse3years1	Integer		0-4	For Grazing period 1: Number of horses up to 3 years (= 0.7 LS*)
HorsePlus3years1	Integer		0-46	For Grazing period 1: Number of horses older than 3 years (= 1.1 LS*)
NbLivestock1	Integer		0-2500	For Grazing period 1: Total number of livestock
LivestockUnits1	Numeric	Number of livestock x conversion factor	0-1814	For Grazing period 1: Total sum of the livestock units
DayGrazing1	Integer	days	0-365	For Grazing period 1: duration of grazing (in days)
GrazingArea1	Numeric	ha	0-148.5	For Grazing period 1: size of area where livestock grazed
Numeric variables for grazing 2-4...For Grazing periods 2-4 see description of grazing period 1				
Cattle6months2			0-73	
Cattle6-24months2			0-103	
CattlePlus2years2			0-120	
SheepGoat1year2			0-600	
SheepGoatPlus1year2			0-1200	
Pony2			0	
Horse3years2			0	
HorsePlus3years2			0-18	
NbLivestock2			0-1200	
LivestockUnits2			0-144	
DayGrazing2			0-165	
GrazingArea2			0-148.5	
Cattle6months3			0-72	
Cattle6-24months3			0-103	
CattlePlus2years3			0-120	
SheepGoat1year3			0-820	
SheepGoatPlus1year3			0-1300	
Pony3			0	
Horse3years3			0	
HorsePlus3years3			0-25	

Variable	Type of data	Units	Range of numeric variables (min-max)	Description (English)
NbLivestock3			0-1340	
LivestockUnits3			0-145.5	
DayGrazing3			0-127	
GrazingArea3			0-196.69	
Cattle6months4			0-72	
Cattle6-24months4			0-81	
CattlePlus2years4			0-84	
SheepGoat1year4			0-600	
SheepGoatPlus1year4			0-900	
Pony4			0	
Horse3years4			0	
HorsePlus3years4			0-16	
NbLivestock4			0-900	
LivestockUnits4			0-103.6	
DayGrazing4			0-76	
GrazingArea4			0-148.5	
TotalGrazing_LSUdha	Numeric	#Livestock*days /ha	0-1644.17	Total sum of the grazing intensity for all grazing periods
SupplementaryFeeding	Boolean	yes/no	-	Additional fodder supply for the livestock
DescFeeding	Text		-	Type and amount of supplementary fodder
Mowing				
Mowing	Integer	1/year	0-4	Number of cuts per year
DateMowing1	Date	dd.mm.yyyy	-	Date of the first cut
DateMowing2-4…	Date	dd.mm.yyyy	-	Dates of the second to fourth cut, if applicable
MowingMachine	Text		-	Type of machine which was used for mowing, e.g. rotarymower, doubleknife, mulcher
CutWidth_m	Numeric	m	0-12	Cutting width of the mowing machine
CutHeight_cm	Integer	cm	0-15	Cutting height above soil level of the mowing machine
DriveSpeed_kmh	Integer	km/h, (mean)	0-20	Speed of the mowing machine, normally mean speed value is given
MowingConditioner	Boolean	yes/no	-	Presence of conditioner, i.e. did the mowing machine have a conditioner to improve drying of the clippings

Variable	Type of data	Units	Range of numeric variables (min-max)	Description (English)
Fertilisation				
Fertilisation	Boolean	yes/no	-	Addition of fertiliser (not including dung depositions by livestock during grazing a parcel)
NbFertilisation	Integer		0-7	Number of fertiliser applications per year
DateFertilisation1	Date	dd.mm.yyyy	-	Date of first fertiliser application
DateFertilisation2-7…	Date	dd.mm.yyyy	-	Date of 2nd to 7th fertiliser applications
Manure_tha	Numeric	t/ha	0-40	Total amount of applied solid manure
Slurry_m3ha	Numeric	m^3/ha	0-80	Total amount of applied pig or cow slurry and biogas residues, respectively.
DescFert	Text		-	Description of applied organic fertiliser
orgNitrogen_kgNha	Numeric	kg/ha	0-371	Amount of organic nitrogen applied
minNitrogen_kgNha	Numeric	kg/ha	0-170	Amount of nitrogen applied, of mineral origin or the organic fertiliser mash from a bioethanol factory (see in DescFert)
totalNitrogen_kgNha	Numeric	Kg /ha	0-433	Sum of applied mineral and organic nitrogen [kg N/ha]
minPhosphorus_kgPha	Numeric	kg/ha	0-350	Amount of phosphorus applied [kg P_2O_5 /ha], of mineral origin or mash from a bioethanol factory (not given for other organic fertilisers)
minPotassium_kgKha	Numeric	kg/ha	0-100	Amount of potassium applied [kg K_2O/ ha], of mineral origin or mash from a bioethanol factory (not given for other organic fertilisers)
Sulphur_kgSha	Numeric	kg/ha	0-25	Total amount of applied Sulphur [kg S/ ha]
Maintenance				
Maintenance	Boolean	yes/no	-	Presence of maintenance measures
Levelling	Text		0-4	Maintenance to break up matted grass covers
DateLevelling	Date	dd.mm.yyyy	-	Maintenance: date of levelling
Rolling	Text		0-2	Maintenance: rolling to level unevenness
DateRolling	Date	dd.mm.yyyy	-	Maintenance: date of rolling
Mulching	Text		0-4	Partial mulching on some spots, e.g. rank patches. The material remains on site after mowing. We consider this not as a mowing event as only a small part of the area is treated.

Variable	Type of data	Units	Range of numeric variables (min-max)	Description (English)
DateMulching	Date	dd.mm.yyyy	-	Date of partial mulching
ShrubClearance	Text	-	0-1	Clearance to avoid shrub encroachment. We consider this not as a mowing event as only individual shrubs are targeted.
DateScrubCl	Date	dd.mm.yyyy	-	Date of shrub clearance
PlantProtectionAgent	Boolean	yes/no	-	Pesticide use: pesticides and herbicides. As pesticides in grasslands are very rare and only used for spot treatment, we do not have further information on this treatment.
Seeds	Boolean	yes/no	-	Seed addition
DescSeeds	Text	-	-	Description of usage of the sowing

*LS – Livestock

Table 2.

Livestock units derived from the type and age of livestock (Chamber of Agriculture Nordrhein-Westfalen 2018).

Grazing species	Age	Livestock units (LSU)
Cattle	< 6 months	0.3
Cattle	6 months-2 years	0.6
Cattle	> 2 years	1
Sheep and goats	< 1 year	0.05
Sheep and goats	> 1 year	0.1
Ponies and small horses	-	0.7
Horses	< 3 years	0.7
Horses	> 3 years	1.1

General description

Purpose: The present dataset summaries management information collected from 2006 to 2016 for 150 grassland plots in three different regions of Germany. Data are based on annual interviews with the respective farmers, land owners or tenants involved in land management activity, using a standardised questionnaire.